A PARATYPHOID-LIKE BACILLUS ISOLATED FROM A DOG.*

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During routine examination of dogs for Negri bodies the following interesting case came under observation.

History.—Three weeks ago the dog was bitten by a rabid dog. Four days ago the dog became sick, with convulsions at short intervals, flowing of saliva, and he was unable to take food. He died at six o'clock this morning, September 20, 1910.

Anatomic diagnosis.—Rabies(?); left purulent pneumonia; acute gastroenteritis; hyperemia of the organs.

A medium-sized adult dog; rigor marked; the body is free from signs of violence. Peritoneum, pericardium, and pleurae normal. Blood-stained purulent froth in the trachea. The right lung is rather dark-red in color and crepitates feebly. The left lung is pale in color; the middle lobe and the upper one-fourth of the lower lobe are gray and crepitation is absent; and a moderate quantity of gray, purulent material exudes from the bronchi and from the cut surface.

The heart appears normal. There is a small amount of bloody mucus in the stomach and the intestines, and the lining of the small intestines is redder than normal. The liver is of about normal size, distinctly mottled, and the cut surface is abnormally bloody. The gall bladder is normal. The pancreas is normal. The spleen appears slightly larger and softer than normal. Both kidneys are bluish-red in color, the capsules smooth and shining, the substance of about normal consistency; the capsules strip readily, the cut surfaces are abnormally bloody, the cortical markings and the medullary striations are prominent. The mucous membranes of the pelves appear to be normal. Both ureters and bladder are normal. The meningeal blood vessels are greatly distended with blood, giving the membranes a decidedly reddened appearance. The brain and cord also appear to contain more blood than normally. Purulent material is not found.

Microscopically the heart is normal. The gray area of the left lung is composed almost entirely of leukocytes. In many places the alveolar walls have disappeared entirely. In areas where the alveolar walls are still present the alveoli are filled with leukocytes, a small number of red blood corpuscles, desquamated epithelial cells and débris. A relatively small number of blood corpuscles are inside of the capillaries. The bronchi are completely filled with leukocytes, desquamated epithelial cells, a small number of red corpuscles and débris. The larger blood vessels are packed with blood corpuscles and a marked leukocytosis is seen there. Bacteria, both cocci and bacilli, are present in large numbers. In the right lung the alveolar walls are enormously thickened and in some places appear absent. The mass is composed almost entirely of blood cells, leukocytes being present in relatively large numbers. The bronchi are nearly filled with red and white blood cells, desquamated epithelial cells, cocci, bacilli, and granular débris. The large blood vessels are filled with blood cells, and leukocytes are present in large numbers.

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The spleen and the liver are congested. Toward the centers of the lobules the liver cells are small, granular, and frequently they are vacuolated. Occasionally a blood vessel is found in the liver which is completely filled with bacteria and débris, and the surrounding liver cells are irregular in shape, granular, the protoplasm taking a brick-red stain with hematoxylin and eosin, the nuclei being lost.

In the kidneys the glomerular tufts contain rather a large amount of blood and appear somewhat distorted, occasionally a small amount of granular, eosin-staining material is seen between the capillary tuft and the capsule. The protoplasm of the epithelial cells lining the renal tubules is granular, the cell outlines are lost but the nuclei take the hematoxylin stain well. In the medullary portion the cells are somewhat better preserved; the capillaries are moderately distended with blood.

The adrenals are normal.

In the hippocampus major and in the cerebral cortex Negri bodies were not found.

Bacteriological examination.—Microscopic examination of stained preparations of cerebrospinal fluid show no micro-organisms, and broth, agar, and serum inoculated with the fluid remain sterile.

Microscopically the blood from the heart shows a moderate number of large bacilli such as are usually found in putrefying animal matter, also a small number of small, short bacilli and some small, slender bacilli. Broth, agar-agar, and blood serum inoculated with blood yield a growth of small, short bacilli and the small, slender bacilli. The small, short bacillus proved to be the colon bacillus and the small, slender bacillus corresponds in nearly all respects to the paratyphoid bacillus.

Microscopically the purulent material from the left lung shows many cocci and bacilli. Isolated and cultivated were *Staphylococcus albus*, a streptococcus, and a bacillus closely resembling the paratyphoid bacillus.

Microscopically smears made of spleen pulp fail to show any micro-organisms. In cultures a bacillus resembling the paratyphoid bacillus was obtained.

A rabbit received a subdural injection of emulsion of the dog's brain on September 21, 1910, and died after several days' paralysis on October 17, 1910. There was great emaciation, the organs of normal appearance, the cerebrospinal fluid and the blood sterile, in the large cells of hippocampus major many typical Negri bodies.

DESCRIPTION OF THE PARATYPHOID-LIKE BACILLUS.

The surface colony on agar-agar is medium-sized, soft, moist, circular, elevated, smooth, convex surface and regular border, semi-transparent, white by reflected light and pale-brown by transmitted light. Microscopically it is brown, dark at the center, gradually fading toward the periphery; finely granular; borders regular. The deep colonies appear as small, opaque, white specks with regular border. Microscopically they are dark-brown, finely granular, lozenge-shaped.

It is a somewhat slender, actively motile bacillus; it stains well with carbol-fuchsin and with methylene blue, and loses the color when treated by Gram's method. Spores are not found.

Broth.—Uniformly clouded within a few hours after inoculation. A heavy pellicle appears after two or three days.

Agar-agar.—A fairly large, soft, moist, elevated growth, with smooth and shining surface and slightly irregular border along the line of inoculation. Semi-transparent, white by reflected light; pale-brown by transmitted light.

Glycerine agar.—Like the growth on agar-agar.

Potato.—A fairly large, light-brown growth spreading over the surface where the potato is wet.

Litmus milk.—Turned slightly red in 24 hours; after five days the milk is nearly white, and after two weeks it is of a cream yellow color and does not show any coagulation. The milk is peptonized.

Gelatine.—No liquefaction.

Indol.—None.

Gas is produced in broth which contains glucose, maltose, levulose, mannit, inosit, dextrin, or galactose. Gas is not produced from lactose or sucrose.

Agglutination.—Distinct agglutination was obtained when mixed with blood of the dog in proportion of approximately 1 to 20. Because of the small quantity of blood which was saved extensive glutination tests could not be made.

Animal inoculations.—1. A guinea-pig weighing 400 gms. received 2 c.c. of a 12-hour culture intraperitoneally on September 30, 1910. It died within 18 hours with acute exudative peritonitis. The abdominal wall edematous and studded with hemorrhages. The paratyphoid-like bacillus was obtained in pure culture from the peritoneal cavity, pleural cavity, pericardial cavity, blood from the heart, lung, spleen, and kidney. Microscopically there are extravasation of blood into the alveoli of the lungs and evidences of degeneration in the cells of the liver and renal cortex, the protoplasm being granular, the outlines indistinct, and the nuclei poorly stained.

2. On October 2, 1910, one loop-full of 24-hour agar growth of the paratyphoid-like organism was suspended in broth and injected subcutaneously in the axilla of a guinea-pig weighing 500 gms. A large swelling appeared within a few hours and the animal died about 24 hours later, with a large hemorrhagic swelling on the thoracic and abdominal walls, peritonitis, and general visceral hyperemia. The bacillus was recovered in pure culture from the site of inoculation, from the pericardial fluid, the heart's blood, pleural fluid, peritoneal fluid, spleen, and urine.

3. On October 6, 1910, a large rabbit was inoculated intraperitoneally with one loop-full of 12-hour agar culture of the bacillus. The rabbit died six hours after inoculation with an acute general fibrinous peritonitis and hyperemia of the solid viscera. The liver markedly fatty. A pure culture of the bacillus was obtained from the peritoneal fluid, from the pleural surface, from the pericardial fluid, from the heart's blood, and from the lung. There were areas of hemorrhage and leukocytic accumulation in the lungs and evidence of degenerative changes in the liver cells.

4. On October 6, 1910, one loop-full of 12-hour agar growth of the bacillus was suspended in broth and injected subcutaneously in the right axilla of a large rabbit A large swelling soon appeared at the site of the inoculation, and the rabbit died on October 9, with hemorrhage and edema of the chest and abdominal walls, fibrinous pericarditis, and pleuritis. The microscopic changes in the lungs, liver, and kidneys were like those in the preceding animals. The bacillus was recovered from the site of inoculation, from the peritoneum, the pericardium, the heart's blood, and from the pleural surface.

5. October 7, 1910, one loop-full of 18-hour agar growth of the bacillus was suspended in broth and injected into the peritoneal cavity of a medium-sized monkey. The monkey died October 11, with general peritonitis, cloudy swelling of the liver and kidneys. The bacillus was recovered from the peritoneum, the pericardium, and the heart's blood. Microscopically the liver was hyperemic and many of the liver cells

contained large and small vacuoles. In the renal cortex the changes were those of acute nephritis. The capillary tufts of the glomeruli were distorted and contained but a small amount of blood. The capsule of Bowman was normal; between the capsule and the capillary tuft granular eosin-staining material (albumen) and a few red blood corpuscles were frequently seen. The epithelial cells lining the tubules in the cortex were somewhat broken down; the protoplasm was granular and the cells were entirely without outline. Most of the nuclei took the stain well. In the medulla the lining epithelium of the tubules was fairly preserved and the capillaries contained a moderate amount of blood.

6. October 7, 1910, one loop-full of 18-hour agar growth of the bacillus was suspended in broth and injected subcutaneously in the axilla of a medium-sized monkey. A large swelling soon developed and the monkey died October 8, with hemorrhage and edema in chest and abdominal walls. There was some degeneration in the cells of the kidneys. The bacillus was recovered from the site of the inoculation, from the peritoneum, and from the heart's blood.

7. A dog fed paratyphoid bacilli for one week died October 9, 1910. The autopsy showed acute enteritis (uncinariasis) and hyperemia of the lungs, liver, spleen, and kidneys. The smaller intestine and the large intestine contained a moderate amount of bloody mucus and an enormous number of small, white worms apparently uncinaria. The mucous membrane was decidedly reddened and showed superficial ulceration. The bacillus was recovered from the heart's blood, from the lung, and from the spleen. The serum of the dog agglutinated the organism at a dilution of 1:50.

8. A healthy dog was fed cultures of the paratyphoid-like bacilli. After having been fed for about a week he became sick, with a loss of appetite and a general downcast appearance. Occasionally he would take milk when offered but would vomit soon after. After a week of sickness the appetite returned and all signs of sickness disappeared. A week after recovery the dog's serum was found to agglutinate the paratyphoid-like bacillus in dilution of 1:200.

TOXIN PRODUCTION.

A shallow layer of broth in a broad flask was inoculated with the paratyphoid-like bacillus from the dog, incubated at a temperature of 36° C. for seven days, passed through a germ-proof filter, and tested on guinea-pigs for toxicity. Four guinea-pigs, each weighing 250 gms., received subcutaneously 0.5 c.c., 1.0 c.c., 2.0 c.c., and 4.0 c.c. of the filtrate, respectively. All four guinea-pigs lived, showing that little or no toxin is produced when the bacillus is grown in broth.

THE THERMAL DEATH POINT.

55° C.—Six tubes of broth were heated in a water bath to 55° C. The temperature having reached the desired height the tubes were quickly inoculated with paratyphoid-like bacilli. At intervals of ten minutes after inoculation one tube was removed from the water bath and placed in cold water. After cooling the tubes were placed in the incubator and kept under observation for five days. If no growth became evident in five days the bacilli were regarded as killed. The result follows:

Time in Minutes at 55° C.....	10	20	30	40	50	60
Result.....	Living	Living	Dead	Dead	Dead	Dead

In the tubes of broth that were kept at 55° C. for ten and twenty minutes a good growth was obtained. All other tubes remained sterile.

60° C.—Six tubes of broth were heated in a water bath to 60° C. The temperature having reached the desired point the tubes of broth were quickly inoculated and kept at a temperature of 60° C. At intervals of ten minutes after inoculation one tube was removed from the water bath and placed in cold water. After cooling the tubes were placed in the incubator and kept under observation for five days.

Of the cultures exposed to 60° C. all were sterile. Exposure to 60° C. for ten minutes is sufficient to kill the organism.

COMPARATIVE STUDY UPON THE PARATYPHOID-LIKE BACILLUS ISOLATED FROM THE DOG, PARATYPHOID BACILLUS, TYPHOID BACILLUS, AND THE COLON BACILLUS.

In the following pages are recorded the results obtained by comparing the paratyphoid-like bacillus from the dog with the following strains of bacilli:

1. A paratyphoid bacillus (No. 10) isolated by me in 1902.[1]

2. A culture marked paratyphoid A, brought from Germany by Dr. Coca.

3. A culture marked paratyphoid B, brought from Germany by Dr. Coca.

4. A culture of paratyphoid bacillus given to me by Captain Bloomberg of the United States Army Medical Corps.

5. A culture of typhoid bacillus the source of which is unknown to me.

6. A culture of colon bacillus.

The culture media used were one per cent normal acid in reaction. Litmus milk and potato were prepared according to usual methods and incubation was done at a temperature of 36° C.

The sugar broth for the fermentation tests was Smith's sugar-free broth containing one per cent of peptone. Immediately before using one per cent of sugar was added, the broth run into graduated fermentation tubes and sterilized for fifteen minutes in the autoclave under a pressure of about ten pounds to the square inch. After sterilization the broth was inoculated in the usual manner and placed in the incubator at the temperature of 36° C. At intervals of 24 hours the level of the fluid in the closed arm was noted and recorded. It was found that gas formation was nearly complete at the end of 24 hours, but a second reading was taken and

[1] *Trans. Chicago Path. Soc.*, 1903, 5, p. 187 (Bacillus No. 10).

recorded 18 hours after inoculation. Gelatine was kept in the refrigerator at a temperature of about 10° C.

PARATYPHOID No. 10.—Medium-sized, semi-transparent, whitish, elevated, circular, soft, moist, surface colony on agar with convex surface and regular border. Brownish by transmitted light. Microscopically they were brown, rather dark at the center and fading toward the periphery, finely granular in appearance, borders regular. The deep colonies, pin-point-sized, rather white specks with regular border, dark-brown, finely granular, lozenge-shaped with regular border on microscopical examination.

It is a slender, actively motile bacillus two to four times as long as it is thick. It stains well with carbol-fuchsin and with methylene blue, and loses the color when treated by Gram's method. Spores are not found.

Broth.—Uniformly clouded within 24 hours. A pellicle forms in three to five days.

Agar-agar.—A medium-sized, semi-transparent, soft, moist, elevated growth along the line of inoculation. The surface is smooth and shining, the border slightly irregular, and by transmitted light it appears light-brown.

Glycerine agar.—The growth corresponds to the growth on agar-agar.

Potato.—A fairly large, soft, moist, light-brown growth spreading over the surface where the potato is wet.

Litmus milk.—Turned slightly red in 24 hours but is not coagulated. Later the milk gradually turns blue and by the end of two weeks it is decidedly more alkaline than the control tube.

Gelatine.—No liquefaction.

Indol.—Negative.

Gas production in sugar broth.—

Glucose—	2.3 c.c. gas in 24 hours;	2.5 c.c. gas in 48 hours.
Maltose—	0.8 c.c. " " " "	1.6 c.c. " " " "
Lactose—	No " " " "	No " " " "
Levulose—	1.5 c.c. " " " "	1.6 c.c. " " " "
Sucrose—	No " " " "	No " " " "
Mannit—	1.7 c.c. " " " "	1.7 c.c. " " " "
Inosit—	No " " " "	No " " " "
Dextrin—	0.6 c.c. " " " "	0.6 c.c. " " " "
Galactose—	0.9 c.c. " " " "	1.4 c.c. " " " "

PARATYPHOID A.—A medium-sized, semi-transparent, whitish, elevated, circular, soft, moist colony with smooth, convex surface and regular border. Light-brown by transmitted light. Microscopically, brown, rather dark at the center, gradually fading toward the periphery, finely granular, border regular. The deep colonies are pin-point-sized, white specks with regular border, dark-brown, finely granular, lozenge-shaped, with border regular. Microscopically it is a slender, actively motile bacillus, two to four times as long as it is thick. It stains well with carbol-fuchsin and methylene blue and loses the color when treated by Gram's method. Spores are not found.

Broth.—Uniformly clouded in 24 hours. A pellicle forms after 3 days.

Agar-agar.—A medium-sized, soft, moist, elevated growth along the line of inoculation. The surface is smooth, convex, and shining; the border is regular, white, semi-transparent by reflected light and pale-brown by transmitted light.

Glycerine agar.—Like the growth on agar-agar.

Potato.—Fairly large, soft, moist, light-brown growth spreading over the surface where the potato is wet.

Litmus milk.—Turned slightly red in 24 hours; the color gradually disappears and at the end of three days the milk is almost pure white. At the end of two weeks it is yellowish and semi-transparent, apparently peptonized. No coagulation.

Gelatine.—No liquefaction.

Indol.—Negative.

Gas formation in sugar broth.—

Glucose—	1.2 c.c. gas in 24 hours;	1.9 c.c. gas in 48 hours.
Maltose—	1.2 c.c. " " " "	2.1 c.c. " " " "
Lactose—	No " " " "	No " " " "
Levulose—	1.5 c.c. " " " "	1.6 c.c. " " " "
Sucrose—	No " " " "	No " " " "
Mannit—	2.6 c.c. " " " "	2.6 c.c. " " " "
Inosit—	0.1 c.c. " " " "	0.2 c.c. " " " "
Dextrin—	0.4 c.c. " " " "	0.5 c.c. " " " "
Galactose—	2.3 c.c. " " " "	2.3 c.c. " " " "

PARATYPHOID B.—The surface colony on agar is medium-sized, elevated, circular, soft, moist, with smooth, convex surface and regular border, white, semi-transparent by reflected light and pale-brown by transmitted light; microscopically it is brown, rather dark at the center, fading gradually toward the periphery, finely granular, regular border.

The deep colony is a pin-point-sized, white, opaque speck with regular border; microscopically it is dark-brown, finely granular, lozenge-shaped; border regular.

It is a slender, actively motile bacillus two to four times as long as thick. It stains well with carbol-fuchsin and with methylene blue and loses the color when treated by Gram's method. Spores are not found.

Broth.—Uniformly clouded in 24 hours; a pellicle forms after three days.

Agar-agar.—A medium-sized, soft, moist, elevated growth along the line of inoculation. Surface smooth, shining, and convex; the border is slightly irregular; white, semi-transparent by reflected light, pale-brown by transmitted light.

Glycerine agar.—The growth on glycerine agar corresponds to the description of the growth on agar-agar.

Potato.—Fairly large, light-brown growth spreading over the surface where the potato is wet.

Litmus milk.—Turned slightly red in 24 hours; after three days it is almost pure white, and at the end of two weeks it is yellowish, semi-transparent, peptonized.

Gelatine.—No liquefaction.

Indol.—Negative.

Gas production in sugar broth.—

Glucose—	2.5 c.c. gas in 24 hours;	2.6 c.c. gas in 48 hours.
Maltose—	0.8 c.c. " " " "	1.7 c.c. " " " "
Lactose—	No " " " "	No " " " "
Levulose—	1.2 c.c. " " " "	1.3 c.c. " " " "
Sucrose—	No " " " "	No " " " "
Mannit—	2.3 c.c. " " " "	2.4 c.c. " " " "
Inosit—	0.1 c.c. " " " "	0.2 c.c. " " " "
Dextrin—	0.3 c.c. " " " "	0.4 c.c. " " " "
Galactose—	1.6 c.c. " " " "	1.7 c.c. " " " "

BACILLUS TYPHOSUS.—The surface colony is a small, soft, moist, elevated, circular colony with smooth, convex surface and regular border. Whitish, translucent by reflected light and pale-brown by transmitted light. Microscopically it is brown, rather dark at the center and fading gradually toward the periphery, finely granular,

border regular. The deep colony is a small, opaque, white speck with regular border; microscopically it is dark-brown, finely granular, lozenge-shaped, with regular border.

It is a small, slender, actively motile bacillus, two to four times as long as thick. It stains well with carbol-fuchsin and with methylene blue and loses the color when treated by Gram's method. Spores are not found.

Broth.—Uniformly clouded in 24 hours. A pellicle forms in five days.

Agar-agar.—A medium-sized, soft, moist, elevated, translucent growth with smooth, shining, convex surface and slightly irregular border. Whitish by reflected light and pale-brown by transmitted light.

Glycerine agar.—The growth on glycerine agar corresponds to the description of the growth on agar-agar.

Potato.—A fairly large, pale-brown growth along the line of inoculation, spreading over the surface where the potato is wet.

Litmus milk.—Turned slightly red in 24 hours; no coagulation. The slightly red color persists.

Gelatine.—No liquefaction.

Indol.—Negative.

No gas produced after 24 or 48 hours in glucose, maltose, lactose, levulose, sucrose, mannit, dextrin, inosit, and galactose broths.

BACILLUS COLI COMMUNIS.—The surface colony on agar is a medium-sized, circular, elevated, soft, moist colony with smooth, convex surface and regular border, semi-transparent, white by reflected light, light-brown by transmitted light. Microscopically it is brown, rather dark at the center and gradually fading toward the periphery. Finely granular, border regular. The deep colony is a small, opaque, white speck, with regular border; microscopically it is dark-brown, finely granular, lozenge-shaped, border regular.

It is a short, thick, motile bacillus, coccoid forms to two to three times as long as thick. As a whole these organisms are shorter and thicker than the typhoid or paratyphoid bacilli.

Broth.—Uniformly clouded in 24 hours. A pellicle forms in three days.

Agar-agar.—Fairly large, soft, moist, elevated growth with smooth, shining, convex surface and slightly irregular border along the line of inoculation. Semi-transparent, white by reflected light and light-brown by transmitted light.

Glycerine agar.—The growth on glycerine agar corresponds to the description of that on agar-agar.

Potato.—Fairly large, light-brown growth spreading over the surface where the potato is wet.

Litmus milk.—Turned decidedly red in 24 hours. Red and firmly coagulated in 48 hours.

Gelatine.—No liquefaction.

Indol.—Positive.

Gas production in sugar broth.—

Glucose—	1.0 c.c. gas in 24 hours;	1.2 c.c. gas in 48 hours.
Maltose—	1.7 c.c. " " " "	2.0 c.c. " " " "
Lactose—	1.5 c.c. " " " "	1.7 c.c. " " " "
Levulose—	1.4 c.c. " " " "	1.4 c.c. " " " "
Sucrose—	0.9 c.c. " " " "	1.0 c.c. " " " "
Mannit—	3.4 c.c. " " " "	3.5 c.c. " " " "
Inosit—	No " " " "	No " " " "
Dextrin—	0.3 c.c. " " " "	0.4 c.c. " " " "
Galactose—	1.7 c.c. " " " "	1.8 c.c. " " " "

PARATYPHOID-LIKE BACILLUS FROM DOG.—The surface colony on agar is a medium-sized, soft, moist, circular, elevated colony with smooth, shining, convex surface and regular border. Semi-transparent, white by reflected light and light-brown by transmitted light. Microscopically it is brown, rather dark at the center, fading toward the periphery; finely granular, regular border. The deep colony is a small, opaque, white speck with regular border; under the microscope it is dark-brown, finely granular, lozenge-shaped, with regular border.

It is a slender, actively motile bacillus, two to four times as long as it is thick. It stains well with carbol-fuchsin and with methylene blue and loses color when treated by Gram's method. Spores are not found. .

Broth.—Uniformly clouded in 24 hours. A pellicle forms in three days.

Agar-agar.—A fairly large, soft, moist, elevated growth with smooth, shining, convex surface and slightly irregular border along the line of inoculation. Semi-transparent, white by reflected light, light-brown by transmitted light.

Glycerine agar.—The growth on glycerine agar corresponds to the description of the growth on agar-agar.

Potato.—A fairly large, light-brown growth spreading over the surface where the potato is wet.

Litmus milk.—Turned slightly red in 24 hours; almost pure white after three days, and peptonized after two weeks.

Gelatine.—No liquefaction.

Indol.—Negative.

Gas production in sugar broth.—

Glucose—	2.3 c.c. gas in 24 hours;	2.4 c.c. gas in 48 hours.
Maltose—	1.7 c.c. " " " "	2.4 c.c. " " " "
Lactose—	No " " " "	No " " " "
Levulose—	1.2 c.c. " " " "	1.3 c.c. " " " "
Sucrose—	No " " " "	No " " " "
Mannit—	2.3 c.c. " " " "	2.4 c.c. " " " "
Inosit—	0.3 c.c. " " " "	0.5 c.c. " " " "
Dextrin—	0.5 c.c. " " " "	0.5 c.c. " " " "
Galactose	1.8 c.c. " " " "	2.0 c.c. " " " "

PARATYPHOID BACILLUS (BLOOMBERG).—The surface colony on agar is a medium-sized (about as large as that of *B. typhosus*), soft, moist, circular, elevated colony with smooth, shining, convex surface and regular border. Translucent, white by reflected light and light-brown by transmitted light. Microscopically, it is brown, rather dark at the center, gradually fading toward the periphery. Finely granular, regular border. The deep colony is a pin-point-sized, white, opaque speck with regular border; microscopically it is granular, lozenge-shaped, regular border.

It is a slender, actively motile bacillus two to four times as long as thick. It stains well with carbol-fuchsin and with methylene blue. By Gram's method it loses the color. Spores are not found.

Broth.—Uniformly clouded in 24 hours. A pellicle appears in five days.

Agar-agar.—A medium-sized, soft, moist, elevated growth with smooth, shining, convex surface and slightly irregular border along the line of inoculation. Translucent, white by reflected light and pale-brown by transmitted light.

Glycerine agar.—The growth on glycerine agar corresponds to the description of the growth on agar-agar.

Potato.—Rather small, pale-brown growth spreading over the surface where the potato is wet.

Gelatine.—No liquefaction.

Indol.—Negative.

Gas production in sugar broth.—

Glucose—	1.1 c.c. gas in 24 hours;	1.9 c.c. gas in 48 hours.
Maltose—	0.1 c.c. " " " "	0.2 c.c. " " " "
Lactose—	No " " " "	No " " " "
Levulose—	1.22 c.c " " " "	1.3 c.c. " " " "
Sucrose—	No " " " "	No " " " "
Mannit—	2.0 c.c. " " " "	2.3 c.c. " " " "
Inosit—	No " " " "	No " " " "
Dextrin—	0.33 c.c. " " " "	0.4 c.c. " " " "
Galactose—	0.7 c.c. " " " "	1.2 c.c. " " " "

ACID PRODUCTION IN SUGAR BROTH.—Broths containing one per cent of glucose, maltose, lactose, levulose, sucrose, mannit, inosit, dextrin, and galactose were inoculated with the bacilli mentioned in the following tables, incubated at a temperature of 36° C., and at intervals of 24 hours the reaction was determined by titrating with 1/20 normal solution of sodium hydrate, using phenolphthalein as indicator. The results are shown in the tables:

TABLE 1.

ACID PRODUCTION BY PARATYPHOID BACILLUS 10.

Days	1	2	3	4	5	6	7	8	9	10
Glucose	1.9	2.0	2.2	2.5	2.5	2.5	2.6	2.7	2.7	2.9
Maltose	1.8	2.0	2.1	2.2	2.3	2.5	2.5	2.5	2.5	2.5
Lactose	1.2	1.3	1.1	1.0	0.8	0.6	0.7	0.7	0.7	0.8
Levulose	2.0	2.2	2.4	2.6	2.6	2.6	2.7	2.8	2.5	2.3
Sucrose	1.2	1.2	1.0	0.7	0.7	0.7	0.6	0.5	0.7	0.8
Mannit	1.8	2.0	2.0	2.1	2.1	2.3	2.3	2.4	2.5	2.7
Inosit	1.0	1.0	0.8	0.7	0.7	0.8	0.7	0.6	0.7	0.7
Dextrin	1.4	1.5	1.5	1.5	1.5	1.5	1.3	1.2	1.2	1.3
Galactose	1.8	2.0	2.2	2.5	2.7	2.9	3.0	3.0	3.0	3.0

In glucose, maltose, levulose, mannit, dextrin, and galactose acid is produced. Lactose, sucrose, and inosit are changed to alkalinity.

TABLE 2.

ACID PRODUCTION BY PARATYPHOID BACILLUS A.

Days	1	2	3	4	5	6	7	8	9	10
Glucose	2.3	2.5	2.5	2.5	2.6	2.6	2.7	2.7	3.0	3.0
Maltose	1.6	1.8	2.0	2.4	2.5	2.5	2.5	2.5	2.5	2.5
Lactose	1.0	1.0	0.9	0.8	0.7	0.7	0.7	0.8	0.7	0.7
Levulose	2.5	2.7	2.7	2.5	2.7	2.8	2.7	2.7	2.7	2.7
Sucrose	1.0	1.0	1.0	1.0	0.8	0.7	0.5	0.5	0.5	0.5
Mannit	2.1	2.3	2.3	2.3	2.4	2.4	2.4	2.5	2.6	2.6
Inosit	2.6	2.8	2.7	2.7	2.8	2.9	2.9	2.9	3.0	3.1
Dextrin	1.5	1.5	1.5	1.5	1.2	0.7	0.8	0.9	0.9	0.8
Galactose	2.5	2.8	2.8	2.8	3.0	3.0	3.0	3.0	3.0	3.1

Acid is produced in the broth containing glucose, maltose, levulose, mannit, inosit, and galactose. Broths which contain lactose, sucrose, and dextrin become alkaline.

TABLE 3.
ACID PRODUCTION BY PARATYPHOID BACILLUS B.

Days	1	2	3	4	5	6	7	8	9	10
Glucose	2.2	2.6	2.5	2.5	2.7	2.8	2.7	2.7	2.8	2.8
Maltose	2.0	2.1	2.2	2.2	2.3	2.5	2.5	2.6	2.5	2.5
Lactose	1.0	1.0	0.7	0.5	0.6	0.6	0.7	0.8	0.6	0.5
Levulose	2.4	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.8
Sucrose	1.0	1.0	0.8	0.6	0.7	0.7	0.6	0.6	0.5	0.4
Mannit	2.0	2.7	2.5	2.3	2.4	2.5	2.5	2.5	2.5	2.5
Inosit	2.2	2.7	2.6	2.6	2.8	3.0	2.9	2.9	3.0	3.1
Dextrin	1.5	1.5	1.4	1.3	1.0	0.7	0.7	0.8	0.7	0.7
Galactose	2.4	2.8	2.6	2.6	2.4	2.7	2.8	2.9	3.0	3.1

Acid is produced in the broth which contains glucose, maltose, levulose, mannit, inosit, and galactose. Broths which contain lactose, sucrose, or dextrin are turned alkaline.

TABLE 4.
ACID PRODUCTION BY BACILLUS TYPHOSUS.

Days	1	2	3	4	5	6	7	8	9	10
Glucose	2.0	2.2	2.2	2.1	2.1	2.0	2.5	2.8	2.6	2.4
Maltose	1.8	2.0	2.0	2.1	2.2	2.3	2.3	2.3	2.3	2.3
Lactose	1.0	1.0	0.7	0.6	0.7	0.7	0.6	0.6	0.7	0.7
Levulose	2.0	2.3	2.2	2.1	2.2	2.3	2.4	2.4	2.5	2.5
Sucrose	1.1	1.0	0.8	0.6	0.7	0.7	0.7	0.7	0.8	0.8
Mannit	2.0	2.2	2.0	2.1	2.0	2.1	2.0	2.0	2.2	2.4
Inosit	0.8	0.6	0.5	0.4	0.4	0.4	0.4	0.5	0.6	0.6
Dextrin	1.0	1.0	1.0	0.9	0.8	0.8	0.7	0.6	0.7	0.8
Galactose	2.0	2.5	2.7	2.7	2.7	2.6	2.5	2.4	2.6	2.8

The typhoid bacillus produces acid in broths which contain glucose, maltose, levulose, mannit, and galactose. Alkali is produced in broths that contain lactose, sucrose, inosit, and dextrin.

TABLE 5.
ACID PRODUCTION BY BACILLUS COLI.

Days	1	2	3	4	5	6	7	8	9	10
Glucose	2.5	2.9	3.0	3.0	2.9	2.8	2.8	2.8	2.8	3.0
Maltose	2.5	2.6	2.5	2.5	2.5	2.4	2.2	2.0	2.3	2.5
Lactose	1.7	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.6	2.7
Levulose	2.6	2.8	2.8	2.7	2.8	3.0	3.0	3.1	3.1	3.2
Sucrose	2.1	2.4	2.5	2.5	2.3	2.2	2.3	2.4	2.5	2.5
Mannit	2.5	2.6	2.6	2.6	2.5	2.4	2.5	2.6	2.7	2.8
Inosit	0.8	0.6	0.7	0.8	0.8	0.8	0.7	0.7	0.7	0.6
Dextrin	1.3	1.1	1.0	1.0	0.9	0.9	0.8	0.7	0.8	0.9
Galactose	3.0	3.1	3.2	3.2	3.2	3.2	3.2	3.3	3.3	3.5

Acid is produced by the colon bacillus in broth which contains glucose, maltose, lactose, levulose, sucrose, mannit, and galactose.

The broth which contained inosit and that which contained dextrin became alkaline.

TABLE 6.

ACID PRODUCTION BY PARATYPHOID-LIKE BACILLUS.

Days	1	2	3	4	5	6	7	8	9	10
Glucose	2.3	2.5	2.5	2.7	2.8	2.9	2.8	2.8	2.9	3.2
Maltose	2.3	2.5	2.4	2.4	2.5	2.5	2.6	2.7	2.7	2.7
Lactose	1.0	1.0	0.8	0.6	0.6	0.7	0.7	0.5	0.6	0.6
Levulose	2.2	2.5	2.7	2.8	2.8	2.8	2.8	2.9	2.9	3.0
Sucrose	1.0	1.0	0.8	0.7	0.7	0.8	0.7	0.7	0.7	0.7
Mannit	2.2	2.5	2.4	2.4	2.4	2.4	2.3	2.4	2.6	2.7
Inosit	2.5	3.0	2.9	2.8	2.9	3.0	3.1	3.1	3.2	3.4
Dextrin	1.0	1.2	1.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Galactose	2.8	3.1	3.0	3.1	3.1	3.2	3.3	3.3	3.3	3.4

The paratyphoid-like bacillus from the dog produces acid in broth which contains glucose, maltose, levulose, mannit, inosit, and galactose. Alkali is produced in broth with lactose, sucrose, and dextrin.

TABLE 7.

ACID PRODUCTION BY PARATYPHOID BACILLUS (BLOOMBERG).

Days	1	2	3	4	5	6	7	8	9	10
Glucose	2.0	2.5	2.4	2.4	2.5	2.6	2.5	2.5	2.6	2.7
Maltose	1.5	1.9	2.0	2.2	2.1	2.2	2.2	2.3	2.4	2.6
Lactose	1.0	1.1	1.0	1.0	1.0	1.1	1.0	1.0	1.0	1.0
Levulose	2.0	2.2	2.3	2.5	2.5	2.6	2.7	2.9	2.9	2.9
Sucrose	1.0	1.3	1.1	1.0	1.2	1.3	1.2	1.2	1.2	1.2
Mannit	1.8	2.1	2.0	2.1	2.2	2.3	2.4	2.4	2.5	2.6
Inosit	1.0	1.1	1.0	1.0	0.9	0.9	0.9	0.9	1.0	1.0
Dextrin	1.3	1.5	1.6	1.7	1.7	1.8	1.6	1.5	1.5	1.6
Galactose	2.0	2.4	2.4	2.5	2.7	2.9	2.8	2.8	2.9	3.1

In order to detect any change in the reaction of the broth without bacterial action a set of tubes with broths containing one per cent glucose, mannit, maltose, lactose, levulose, sucrose, inosit, dextrin, and galactose was kept at a temperature of 36° C., and at intervals of 24 hours the reaction was determined by titrating with 1/20 normal solution of sodium hydrate with phenolphthalein as indicator.

TABLE 8.

CHANGES IN REACTION OF CONTROL BROTHS.

Days	1	2	3	4	5	6	7	8	9	10
Glucose	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.2
Maltose	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.2
Lactose	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.2
Levulose	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.2
Sucrose	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.2
Mannit	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.2	1.2
Inosit	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.2
Dextrin	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.2
Galactose	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.6	1.6

Broth that contained galactose was slightly more acid than the others. In all the acidity increased slightly during the period of ten days.

INTERAGGLUTINATION OF THE VARIOUS STRAINS OF BACILLI STUDIED.—Rabbits were inoculated intraperitoneally with cultures of each of the different strains studied and the agglutinating power of the resulting serum determined with respect to each of the strains in each case. Unless otherwise stated two intraperitoneal inoculations were made one week apart. A week after the second inoculation the rabbit was bled. The blood was allowed to clot and the clear serum withdrawn.

1. The serum obtained in this way against paratyphoid bacillus No. 10 agglutinated this bacillus in a dilution of 1:400 and the Bloomberg bacillus in a dilution of 1:800; none of the other strains were agglutinated.

2. The serum against paratyphoid bacillus A agglutinated this bacillus in a dilution of 1:2,000, paratyphoid bacillus B in a dilution of 1:1,000, and the bacillus from the dog in dilution of 1:200; the other strains were not agglutinated.

3. The serum against paratyphoid bacillus B agglutinated this bacillus in a dilution of 1:4,000 and paratyphoid bacillus A in a dilution of 1:1,000; the other strains were negative.

4. The serum against the typhoid bacillus agglutinated this bacillus in a dilution of 1:400 and had no effect whatever on any of the other strains.

5. The serum against the colon bacillus agglutinated this bacillus in a dilution of 1:8,000, paratyphoid No. 10 in a dilution of 1:100, and paratyphoid Bloomberg in a dilution of 1:400; it had no effect on any other strain.

6. The serum against the paratyphoid-like bacillus from the dog agglutinated this bacillus in a dilution of 1:16,000; it had no effect on any of the other strains. In this case the rabbit received three intraperitoneal inoculations.

7. The serum against paratyphoid bacillus (Bloomberg) agglutinated this bacillus in a dilution of 1:8,000; paratyphoid No. 10 in a dilution of 1:200, paratyphoid A in a dilution of 1:50, paratyphoid B in a dilution of 1:100, and typhoid bacillus in dilution of 1:100.

CONCLUSIONS.

According to the evidence brought forth in the preceding pages the following conclusions seem to be justified.

The organism isolated from the dog and described in the foregoing belongs to the group of paratyphoid bacilli.

Because of the fact that the dog had rabies infection with the paratyphoid bacillus must be considered secondary. In all probability it was the immediate cause of death.

That infection took place before death is shown by the agglutinating power of the dog's serum.

The bacillus isolated is highly pathogenic for guinea-pigs, rabbits, and monkeys. After death of the animal the organism can be found in all organs and it has a tendency to produce pneumonia.

Apparently, soluble toxin is not produced.

Exposure to a temperature of 55° C. for 30 minutes kills it. At a temperature of 60° C. it is killed in 10 minutes.

It is doubtful whether feeding the organism to a healthy dog will produce a fatal infection.

Gas production and acid production in sugar broth varies greatly with different strains of paratyphoid bacilli.

The strains of bacilli reported on in this paper vary greatly in their behavior toward agglutinating serums.

Practically no differences were found between the culture marked paratyphoid bacillus A and that marked paratyphoid bacillus B.